Preliminary Assessment of the CO$_2$ Storage Capacity in the Lower Copper Ridge Dolomite (Upper Cambrian), Northeastern Kentucky*

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Search and Discovery Article #80679 (2019)**
Posted June 3, 2019

*Adapted from poster presentation given at 2018 AAPG 47th Annual AAPG-SPE Eastern Section Joint Meeting, Pittsburgh, PA, October 7-11, 2018
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Abstract

The Kentucky Geological Survey drilled its 1 Hanson Aggregates stratigraphic research well, Carter County, northeast Kentucky, to identify potential CO$_2$ storage reservoirs in the Knox Group and deeper strata, identify potential confining intervals, and test reservoir rock properties in the southern Appalachian Basin. The lower Copper Ridge Dolomite of the Knox (3313 - 4170 ft) was evaluated to determine porosity and permeability as a standalone CO$_2$ storage reservoir. The interval is composed almost exclusively of dolomite with occasional thin sandstone and shale interbeds. Average porosity calculated in the entire lower Copper Ridge is 5.8% and permeability measured in core plugs ranges from less than 0.001 mD to 34 mD.

A step-rate test was conducted in the Copper Ridge from 3695–3945 ft, an interval that showed substantial vugular porosity in cores. The interval was isolated at its base by a cast iron bridge plug and cement plug at 3945–3963 ft to prevent pressure communication and fluids loss to underlying strata during testing, effectively abandoning the wellbore below 3963 ft. The interval was swabbed through tubing in 19 runs prior to the step-rate test to recover formation water, recovering 43 barrels of water. Analysis of the water sample showed 114,900 mg/l residue total dissolved solids. A static bottom hole pressure was obtained followed by the step-rate test. The test featured stable pumping rates from 0.25 to 5.5 BPM in 5-minute steps but was terminated when the supply of fresh drinking water test-fluid was exhausted. After completion of the final step the well was shut-in and pressure falloff monitored for about 12 hrs. The lower Copper Ridge test interval fractured at a pressure of 1979 psi, or a fracture gradient of 0.60 psi/ft. Average permeability of the test interval calculated from the falloff pressure was 15.3 mD.

Porosity and net reservoir thickness for calculating potential CO$_2$ storage volume in the lower Copper Ridge were determined using an industry-standard 7% porosity cutoff. Average reservoir thickness in the study area at the cutoff is 71 ft and porosity is 9.0%. Net lower Copper Ridge reservoir pore volume in the 615,450-acre potential storage area is about 4.0 million acre-feet. CO$_2$ storage volume was determined using the methodology of the U.S. DOE, Office of Fossil Energy, National Energy Technology Laboratory. Estimated P50 CO$_2$ lower Copper Ridge storage volume is about 1320 metric tons/acre and 811 million metric tons in the study region. Thus, about 760 surface acres would be required to store 1 million metric tons of CO$_2$, the average annual CO$_2$ released by a coal-fired power plant in the Ohio River industrial corridor.
Abstract
The Kentucky Geological Survey (KGS) in collaboration with the Department of Energy (DOE) has conducted a preliminary assessment of the storage capacity of the Lower Copper Ridge Dolomite in northeastern Kentucky, USA. The Lower Copper Ridge (LCR) carbonate strata, deposited during the Upper Cambrian, are exposed along the eastern border of Rowan County, Kentucky. The LCR is a potential source rock formation for 

CO₂ storage. The carbonate rock is composed of dolomite with a large fraction of micropores, vugular porosity, and interstratified clay minerals, which may provide pathways for CO₂ migration. The reservoir is bound by confining intervals composed of shale and sandstone.

The study area is located in the Appalachian Basin, a region that has been extensively sampled for 

CO₂ storage potential. Previous assessments have identified the LCR as a promising target for 

CO₂ injection due to its high permeability and porosity. The geologic setting and potential for 

CO₂ injection are discussed in this paper, along with the results of laboratory and field tests.

Geomechanical Rock Properties

Dynamic rock properties, including elastic moduli (Young's modulus and bulk modulus), were measured in core plugs from the LCR. The results show that the LCR is a stiff material with a high Young's modulus and a low Poisson's ratio. The bulk modulus is in the range of 10 to 15 GPa, while the Poisson's ratio is around 0.15. These properties indicate that the LCR is a good candidate for 

CO₂ storage because it can accommodate 

CO₂ injection without significant deformation.

Porosity and permeability were measured in core plugs from the LCR. The average porosity is 5.8%, and the permeability ranges from 0.001 to 34 mD. These values are sufficient for 

CO₂ storage, as they are higher than the typical values required for commercial storage.

Subsurface pressure plots and gas chromatograms from previous 

CO₂ injection tests in the region show that 

CO₂ can be stored at high pressures without significant leakage. This indicates that the LCR is a good candidate for 

CO₂ storage.

Acknowledgments
The authors would like to thank the Kentucky Geological Survey for their support and the Department of Energy for their funding. We also thank the Appalachian Regional Commission and the Commonwealth of Kentucky for their support.

References

